

cause a confused broadening (see the *Electrician* of February 26, 1897, vol. 38; top of p. 569). I was still too much influenced by the idea of random atomic motions, instead of precise electronic orbits.¹ The real effect, as perceived in advance by Lorentz and realised clearly by Zeeman, was much sharper and more beautiful than that, and my suspicion of a more complex or mixed effect was unnecessary; the simple Lorentz theory served, just as cited in that same article of mine in the *Electrician* (except that I made a slip and gave a value for the perturbed frequency which I correct in the second following issue, p. 643 of the same vol. 38. Some remarks on e/m , interesting from an historical point of view, will also be found in that issue, and an extremely short formulation of the theory, thus: "Magnetised change of centripetal force, $eHr\omega = mrd\omega^2$, whence $d\omega = eH/2m$." Here also is the record of a temporary slip about the sign of the effect, made by Zeeman himself, for he at first announced that the radiating particle was a *positive* charge).

At the same time, a pure doubling or a tripling, characteristic of a truly circular or elliptic orbit perturbed by an apsidal or a precessional motion, is not the last word; for, though this is the standard of simplicity, each line in the spectrum is liable to have peculiarities of its own, depending on the nature of the electronic orbit which is magnetically perturbed; and hence there is found, not indeed mere broadening, but a quadrupling, sextupling, and other varieties of effect, such as are now well known, but which I confess surprised me when first I saw their indications.

In the *Phil. Mag.* for December, 1897, is an important theoretical paper by Sir Joseph Larmor, "On the Theory of Magnetic Influence on Spectra, and on the Radiation from Moving Ions." Towards the end of this paper he deduces his fundamental expression for radiative power, as proportional to square of charge and square of acceleration. Non-radiation from charges moving at uniform speed *seems* to be indicated—which would be very convenient in making unperturbed atoms permanent—but unfortunately centripetal acceleration seems equally destructive to their constitution, were it not for the modern device of quanta.

In this same volume of the *Phil. Mag.* (vol. 44, pp 55 and 255) are two additional papers by Zeeman, also reproduced in the book under review, constituting the real publication of the occurrence of definite doublets and triplets in the magnetic field; and they are followed in this book by another

one giving metrical results obtained photographically.

Photographic records of the effect were, indeed, tried for by other experimenters, though without success (see *NATURE*, vol. 56, p. 420). In *NATURE*, vol. 57, p. 173, however, Thomas Preston reports complete success, in Dublin, with a fine grating belonging to the Royal University of Ireland, mounted in accordance with Rowland's geometrical-slide design. But on p. 192 of the same volume a meeting-report shows that Zeeman had exhibited specimens of similar photographs at the Amsterdam Academy a month earlier; and he was now able to apply the photographic method to the obtaining of more exact measurements, as mentioned in the *Phil. Mag.* for February, 1898, p. 197. See also Preston, p. 325 of the same volume (vol. 45), by whom a plate showing the various appearances with great distinctness is submitted. A few pages further on (p. 348) is a communication, which still further emphasises complexities and individual peculiarities in the magnetised lines, by Prof. Michelson, who here begins to apply to them his remarkably powerful "visibility" test, which was first elaborated in the *Phil. Mag.* for September, 1892 (vol. 34, p. 280), as a sequel to his earlier more theoretical paper in April, 1891, and is now employed with such skill and brilliant success at Pasadena to measure the diameter of stars.

In further papers by Zeeman the spectrum of *iron* is specially examined, and a lack of symmetry detected in some of its lines. And presently the resolving power of the Michelson echelon is pressed into the service for the further examination of details, with results which are described and expounded through the remaining 200 pages of this interesting memorial volume.

The extreme importance of Zeeman's great discovery, and the admirable way in which he worked it out with the inspiring theoretical assistance of Prof. H. A. Lorentz—so that theory and experiment went hand in hand, as it is to be wished they did more often—may be allowed to justify and excuse this somewhat personal welcome of its twenty-fifth anniversary by an English physicist.

OLIVER LODGE.

The Kaiser Wilhelm Institute.

Festschrift der Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften zu Ihrem zehnjährigen Jubiläum Dargebracht von ihren Instituten. Pp. iv+282. (Berlin: Julius Springer, 1921.) 100 marks.

THE Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften owes its origin to the action of certain leading industrialists

¹ Incidentally and generally, it cannot be unknown, but it seems to be sometimes overlooked, that every *regularity* tends to evade the equipartition of energy difficulty: for Maxwell's proof requires the motions to be not only interchangeable, but also completely random.

connected with the principal chemical establishments of Germany who were concerned as to the future of science, and more particularly of physical science, in that country. In their opinion the German university system no longer sufficed to meet modern requirements in regard to research in abstract science, and they suggested to the All Highest the creation of an institution which should be wholly and exclusively devoted to research, and should be staffed by men of proved capacity to undertake its successful prosecution. They so far succeeded in impressing the Emperor with their views that he in his turn suggested to his memorialists, and to others who sympathised with them, that they should themselves find the money needed to endow and equip the contemplated institution, and, by way of showing his practical interest in the project, he further indicated what amounts the several industrial concerns, or their representatives, might be expected to contribute.

The society was duly inaugurated with all the pomp and ceremony which usually characterised any function or enterprise with which William II. desired that his name should be specially associated, and the occasion was further made memorable by the address which the late Prof. Emil Fischer then delivered.

The institution thus established at Berlin-Dahlem has now been in existence for ten years, and it has been thought expedient by those connected with its working to celebrate its "zehnjährigen Jubiläum" by the publication of a "Festschrift." By us a jubilee is usually understood to mean the celebration of a period extending over fifty years, corresponding to the Grand Sabbatical Year of the Jews, although there has grown up a certain laxity in the use of the term which is frequently held to denote a season or occasion of public festivity, which may or may not recur at stated periods. What were the precise reasons in the minds of those responsible for the management of the institution which led them to direct public attention to it at this particular time can only be surmised, for there is nothing by way of preface or introduction to the "Festschrift" to inform us.

The celebration of a jubilee after so short an interval as ten years, during half of which time the work of the society was seriously disturbed and hindered by the war, has, when we have regard to the unsettled condition of Germany, somewhat the appearance of a political move. It will not be forgotten that it was at the Kaiser Wilhelm Institute "for the Promotion of Science" that Geheimrat Haber made his experiments on poison gas, prior to the Battle of Ypres,

which initiated a mode of warfare which is to the everlasting discredit of the Germans. We are not aware that the present Government has shown itself inimical to the interests of science; unlike Coffinhal, it has never pronounced "La République n'a pas besoin de savants." On the contrary, Germany realises that she owes too much to science during the last half-century, and especially during the critical years of the war, for her to be unmindful of its benefits. Whatever form of government she may ultimately adopt, she is too much beholden to science to neglect its claims, and there is no reason to believe that these claims will be less adequately met by a republic than by a monarchy. At the same time, it cannot be doubted that the impoverishment of the country will react disastrously upon the position and prospects of all institutions which, like the Kaiser Wilhelm Society, are dependent upon public funds or private munificence.

Although we are prepared to welcome every sign of renewed scientific activity in Germany, it cannot be said with strict regard to truth that this "Festschrift" is in any sense epoch-making. There is certainly nothing jubilant about it. It is divided into two main portions, one of which, consisting of thirty-three short papers extending in all over 243 pages, deals with natural science; the other, consisting of four papers, is concerned with the science of history, and is comprised within eighteen pages. Of the natural science papers the greater number relate to relatively small points of bio-chemistry; the others are about equally divided between subjects of pure and applied chemistry and physical chemistry. Among the contributors are Abderhalden, "Zur Kenntniss von organischen Nahrungsstoffen mit spezifischer Wirkung"; Armbruster, "Tiere als Tierzüchter—Eine Erklärung ihres Sozialismus"; Einstein, "Eine einfache Anwendung des Newtonschen Gravitationsgesetzes auf die Kugelförmigen Sternhaufen"; Haber, "Über Wissenschaft und Wirtschaft"; Carl Neuberg (who edits the volume), "Über den Zusammenhang der Gärungserscheinungen in der Natur"; Prandtl, "Neuere Einsichten in die Gesetze des Luftwiderstandes"; and Stock, "Die Chemie des Leichtflüchtigen." Many of the papers are short historical summaries of the present state of knowledge on the particular point dealt with. Some of them, in fact, read as if they were amplified excerpts from university courses of lectures. Others are simply *réchauffés* of work which has been published in detail elsewhere.

The papers on the science of history comprise one by von Harnack on "Die Apokalyptischen

Reiter," and—curious association—two short notices relating to the Emperor William I. These deal with the Frankfort Congress of 1863, and with episodes in 1870 at Ems, and at Sedan. The notes of the conversation with the French Ambassador Benedetti at the former place (July 13 and 15, 1870), and with Napoleon III. at the latter place (September 2, 1870), are of historical interest, and are among the few papers of permanent value contained in the book.

The price of the brochure, which is issued in paper covers, is stated to be 100 marks, which, considering the present value of German currency, is not excessive, however significant of Germany's financial straits. The book is admirably printed on excellent paper, and is suitably illustrated. It does credit, in fact, to the eminent firm by which it is published. The war and its consequences have evidently had no detrimental effect on the typographical excellence of book production in Germany.

Fish Preservation.

Fisheries—England and Wales. Ministry of Agriculture and Fisheries. Fishery Investigations: Series 1, Freshwater Fisheries and Miscellaneous. Vol. 2, No. 1, The Methods of Fish Canning in England. Pp. 25. (London: H.M. Stationery Office, 1921.) 2s. 6d. net.

THE development of methods of preserving fish was a matter of national importance during the war, and the present account is founded on investigations started in that period. The fish used for canning are mostly surface-feeding and living fish, such as sprats (or bristling), sardines (or pilchards), tunny and bonito, herring and mackerel, the only other fish of any importance being the salmon caught in America on its migration to fresh water for breeding. Of British fish there is a great excess of herring in the normal fisheries, and, given suitable fishing gear, large quantities of sprats can also be obtained on all coasts. Mackerel are at times abundant, but there is little certainty of heavy catches year by year; pilchards are local to Cornwall, and the immature forms (sardines), so extensively tinned in France, Spain, and Portugal, are not caught in quantity. There was one British sprat cannery before the war, but herrings were put up at the great herring ports in oil or with tomato, the product being in some cases excellent. Excess sprats were generally used for manure, while herrings were salt-pickled and barrelled for export, the price being two or three

for a penny. The latter is an "unspeakable" product, which has never found favour in this country, and fresh methods of preservation are urgently requisite for the utilisation of herrings as a cheap form of food. The markets, too, of Central and East Europe, which took most of this product, are disorganised, and it is doubtful whether they can ever be recreated, as there would seem to be a real improvement in Continental taste, brought about by the temporarily improved food conditions of the war.

The success of different kinds of fish as canned products depends largely on the fat which lies under the skin and between the muscles. Salmon is canned or frozen in air (dry frozen) on the Pacific coast almost immediately when caught, certainly before *rigor mortis* has set in; the same is, to some degree, true also of the Norwegian sprats (bristling), of which there are about eighty factories in operation. The difficulty in Great Britain is that no port has a herring or sprat season extending through more than three or four months, and a factory with modern appliances and trained packers cannot be run profitably for such a short season. The fish required at other times must be brought in by rail, and this doubles the cost, while the actual fish has passed through its *rigor* and is deteriorating. It would seem necessary to get the fish as fresh as possible and to discover some method of preservation in bulk for subsequent packing, the process being one which would in no wise alter its composition or flavour.

Experiments with brine freezing and subsequent cold storage are described, but difficulty was experienced in the caking of sprats into masses and the salting, due both to the small size of the fish and to an excessive cold-store temperature "just under 30° F." Both these difficulties might perhaps be got rid of, but the total cost of the actual freezing, storage, transport, etc., would probably average 3d. per lb., which only a first-rate product could bear. Unfortunately, British sprats, as at present caught, are shown to be by no means such a product, being indeed much inferior to the Norwegian. According to the tables, they varied in fat from 5 to 23 per cent., protein being 15 to 20 per cent., ash about 1.5 per cent., the rest being water, which, with fat, roughly forms 80.5 per cent. The problem is to catch sprats of the right composition for pickling. The English fish is winter and spring caught, while the Norwegian fishery is in summer and autumn. The reproductive cycle has doubtless something to do with the quality, but little is as yet known of the life-history of the English fish. The difference lies probably, not in the fat contents, but in other